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ABSTRACT

This study examines recall of narrative prose for evidence of underlying structures such as the grammar used in the story's sentence structure. Subjects listened to repeated presentations of a tape recording of two pages from a history book, with verbals collected after each presentation. The subjects used in this experiment were 13 undergraduate students at the University of California, San Diego, who volunteered for the experiment in return for class credit or payment. The results show that serial structures and story grammar structure are important factors in the memory and recall of narrative passages. (Author/RB)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes a study of the recall of narrative prose. Subjects listened to repeated presentations of a tape recording of two pages from a history book, with verbal recalls collected after each presentation. The elements of the passage were organized according to a serial structure based on order in the passage and a story grammar structure based on causal relations. While the serial structure at first influenced which elements of the passage were remembered, as the subjects remembered more of the passage, the story grammar structure became the dominant influence over the elements remembered on subsequent recalls.

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THE STRUCTURE AND RECALL OF NARRATIVE PROSE

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Learning a complex story often requires several readings. Each re-reading of the passage adds to the overall understanding, with the new knowledge picked up at a reading being added to the general semantic structure of the previously acquired knowledge. Recent developments in the study of semantic memory (Norman, Rumelhart, and the LNR reearch group, 1975; Rumelhart, 1975) suggest ways of investigating how a person's understanding of a prose passage develops with successive exposures to the passage. In this study, subjects listened several times to a tape recording of a prose passage, and their developing knowledge was followed by collecting recalls after each presentation of the prose passage.

In the past few years, a number of studies have been published on the organization and recall of prose. Generally they have been concerned with descriptive prose, and the structures proposed for the organization of prose have been simple hierarchies. Meyer and McConkie (1973, see also Meyer, 1975) analyzed descriptive passages about nuclear reactors and parakeets into a hierarchy of "idea units" and found that idea units higher in the hierarchy were more frequently recalled than idea units lower in the hierarchy. Frederiksen (1972, 1975) looked at the recall of set relations in prose and reported that most errors were related to the acquisition process, rather than the memory retrieval process. Crothers (1972) has developed a method for characterizing stimuli and scoring responses for recall of descriptive prose involving set relations.

Monk and Kintsch (1974) measured reaction times to answer true-false questions or recognize sentences after reading paragraphs of varying length. They found that the time to correctly respond "true" or recognize an old sentence increased with the length of the paragraph, while the time to correctly respond "false" or reject a new sentence was independent of the length of the paragraph.

Rumelhart (1975) has proposed a grammar for understanding narrative prose and representing the information in a network structure. In the Rumelhart story grammar, stories are decomposed into smaller units, such as settings, episodes, actions, reactions, events, and goals. These smaller units, which may be decomposed further, are interrelated with causal predicates, such as INITIATIVE, MOTIVATE and ALLOW. For example, an episode consists of an event which INITIATES a reaction. (A portion of the structure which is produced when the story grammar is applied to a history text is shown in Figure 1.) The story grammar provides a useful tool for investigating the developing knowledge structures of the learner. This paper examines recall of narrative prose for evidence of underlying structures such as those proposed by the story grammar.

METHOD

The text used in this study was a passage about two pages in length (around 925 words) from Morison's The Oxford History of the American People (1965, pp. 638-640). A text from a history book was chosen because of its similarity to materials used in real educational situations and because it could be analyzed with the story grammar which had been developed to describe naratives of human

actions. A portion of the text is quoted in the results section of this paper. The text is a self-contained description of General Grant's early forays in the West: The capture of Forts Henry and Donelson and the battle of Shiloh.

The experiment consisted of playing a tape recording of the text four times and collecting verbal recalls after each presentation of the text. The subjects were first told that they would be listening to a tape recording of approximately two pages from a history book, that the recording would be played four times, and that after the recording was finished each time they would be asked to tell all they could remember. The tape recording, which lasted about six minutes, was then played for the subject and when it finished, the subject was asked to tell everything he could remember from the passage. The subject indicated that he could not remember anything else, the passage was played again, and the subject was then asked to tell all that he could remember, including things that he had mentioned earlier. This sequence was repeated for a total of four trials, where a trial consists of a presentation of the tape recorded passage and the subsequent recall.

The subjects used in this experiment were 13 undergraduate students at the University of California, San Diego who had volunteered for the experiment in return for class credit or payment. No subject had any unusual knowledge or interest in the American Civil War.

RESULTS

Method of Analysis

In order to analyze the recalls, the Morison text, consisting of 47 sentences, was divided into 143 "facts." These "facts" correspond to the units described by the story grammar such as settings, actions, consequences, goals, and plans. Although the method of dividing the text into facts was not completely systematic, in general a fact corresponds to a phrase or simple sentence in the original text. Many of the facts could be decomposed into simpler propositions, but that was not necessary for this analysis. Examples of several facts can be seen as the numbered statements in Figure 1.

The Story Grammar Structure

The facts derived from the Morison text were structured according to the story grammar. A small portion of the story grammar structure is shown in Figure 1. This structure represents some of the facts derived from the following section of text:

> In the summer of 1861 the Confederates began to throw up earthworks at various points along the Mississippi where the old Spanish forts used to choke down-river trade. In order to force a passage past them, J. B. Eads, an engineer of St. Louis, constructed a fleet of river gunboats, each with a partially armored casemate shaped like a mansard roof, and a flat-bottomed hull.
>
> Less than 50 miles up the Ohio from Cairo the Tennessee and Cumberland rivers offered parallel routes into Tennessee, Alabama, and Mississippi. Grant observed that Forts Henry and Donelson, the Confederate earthworks

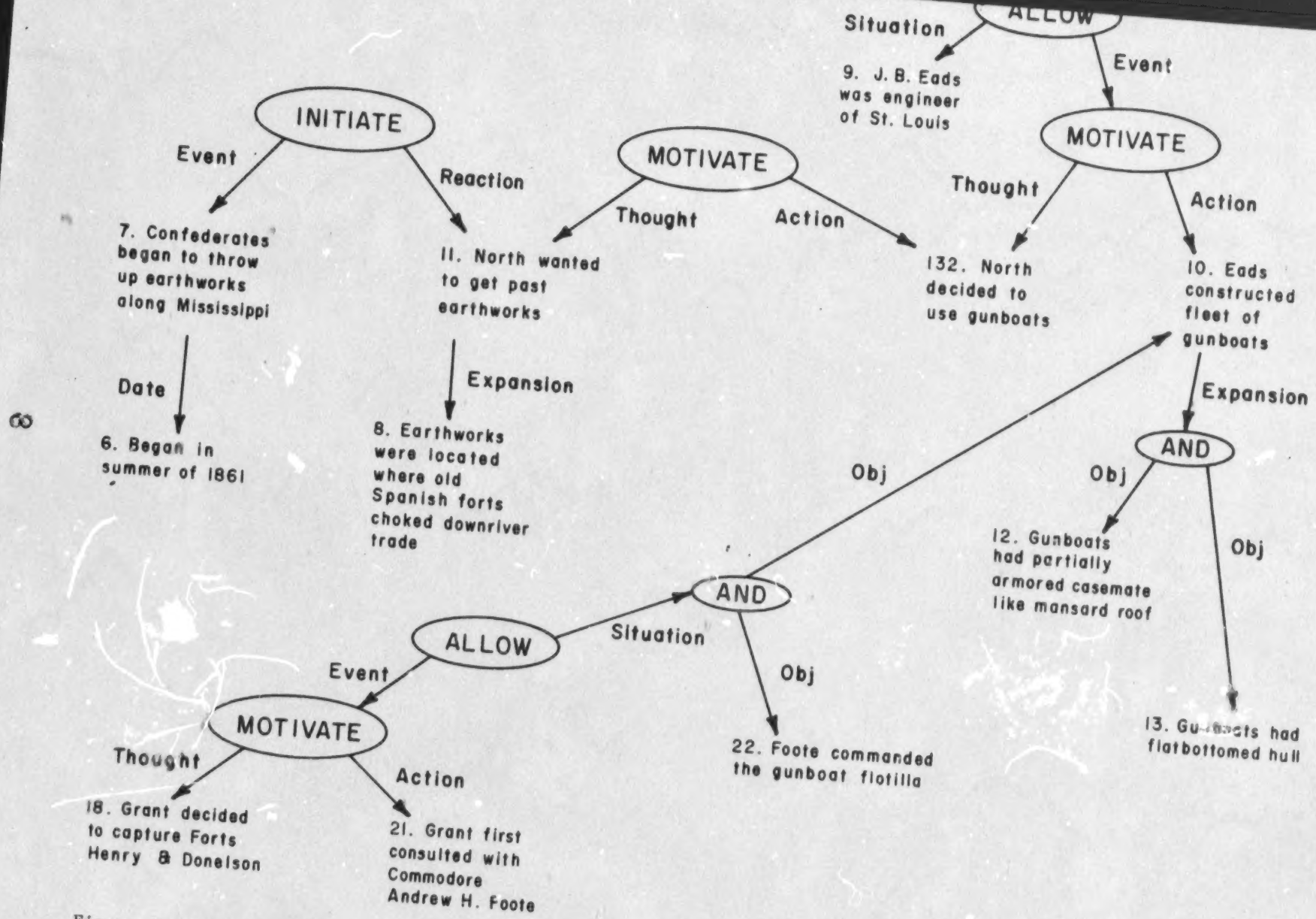

Figure 1. A portion of the story grammar structure for the passage.

> which closed these rivers, were the twin keys to the rebel West. Their capture would open a navigable waterway into the enemy's center and drive in his flanks. On 30 January 1862 Grant, after consulting with Commodore Andrew H. Foote, commanding the gunboat flotilla, obtained Halleck's reluctant consent to try, and was furnished with the necessary transports and gunboats. (Morison, 1965, page 639.)

The complete story grammar structure for the passage contains 143 facts interconnected with about 200 predicates or relations: 131 of these facts are explicitly contained within the text, and 12 "implicit facts," while not explicitly mentioned in the passage, were required by the story grammar. For example, the story grammar requires that all activities, such as "Eads constructed a fleet of gunboats," be motivated by plans. I therefore added the plan, "North decided to use gunboats," as an implicit fact even though it was not explicitly mentioned in the Morison text (implicit facts are shown in parentheses in Figure 1). For any structure such as the story grammar structure, we can count the facts which are neighbors of any given fact. A neighboring fact is one which is connected to the given fact by a single relation or predicate. For example in the structure shown in Figure 1, fact 7 has three neighbors (facts 6, 8, and 11), while fact 8 has only one neighbor (fact 7).

The Serial Structure

The 143 facts were also structured in a simple linear chain according to the serial order in which the facts occurred in the original passage. This is referred to as the serial structure. Except for the initial and final facts, all facts in the serial structure have two neighbors. Note that the serial structure contains the same implicit and explicit facts included in the story grammar analysis. The implicit facts were added in a position to produce the most acceptable narrative.

Scoring of Recalls

For each recall of each subject, I noted whether each fact was absent, part-correct, or correct in the recall. A fact was scored as correct if the recall contained a substantially correct paraphrase of the fact. A fact was scored as part-correct if some of the material in the fact was mentioned in the recall (i.e., the recall might contain a partially correct or incorrect statement of the fact). If the information in the fact was not mentioned at all, it was scored as absent.

As an example consider the fact: "The Confederates began to throw up earthworks along the Mississippi." The fact was scored as correct in this recall: "...it talked about how the Confederate forces had taken over most of the Mississippi by sort of throwing up earthworks...." The fact was scored as part-correct in this recall: "... and the Confederates were starting to move in along the Mississippi...."

I thus obtained the following data for analysis:

a) For each subject on each of four trials, each fact scored as absent, part-correct, or correct.

b) A story grammar structure interconnecting the 143 facts.

c) A serial structure interconnecting the 143 facts.

Recalls

The average performance of subjects shows a steady, almost constant improvement on successive trials (Figure 2). The variation among subjects, however, was surprisingly large. Combining the four trials, the worst subject got 14 facts correct and 56 facts part-correct, while the best subject got 251 facts correct and 90 facts part-correct. A fact was given a score of two if it was correct, one if it was part-correct, and zero otherwise. Thus the range of scores (combining all trials) was from 84 to 592.

To get a detailed look at how neighbors in the story grammar structure affect the recall of facts, I looked at each of the first three trials of a subject, classified each fact as absent, part-correct, or correct, and then noted the score for that same fact on the subject's next trial. All scores were combined to yield a score on trial $n+1$ for facts which were absent, part-correct, or correct on trial n, averaged over values of n from one to three.

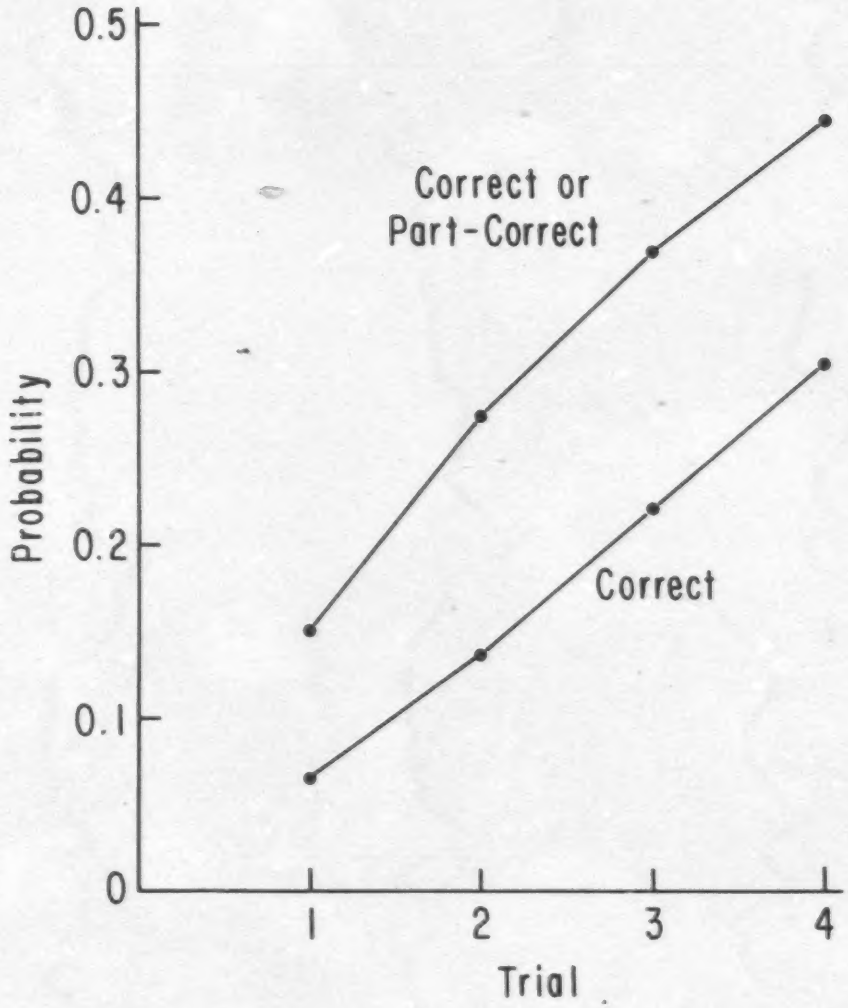

Figure 2. Overall performance of the subjects on the recall task.

First consider the effect of the complete story grammar structure. Neighbors in this analysis are called a priori story grammar neighbors, since the number of neighbors in the complete story grammar structure are counted whether or not the subject has actually recalled them on any particular trial.[1] The number of a priori story grammar neighbors appears to have little, if any, effect on the subsequent recall of facts (the left graph of Figure 3; the slopes of the regression lines shown in Figure 3 are given in Table 1).[2]

In contrast to the number of a priori neighbors in the complete story grammar structure, the remaining graphs in Figure 3 show the effect of the number of neighbors which the subject actually mentioned (as part-correct or correct) on trial n. The center graph of Figure 3 shows the average scores on trial n+1 for facts which were absent, part-correct, or correct on trial n as a function of the number of story grammar neighbors of that fact which were mentioned on trial n. There is a clear positive effect. No matter what the initial status of the fact, as the number of its story grammar neighbors mentioned on a trial increases, the fact is more likely to be remembered on the next trial.

One question is whether alternative structures might also show an effect comparable to that of the story grammar structure. A simple alternative is the serial structure, linking the facts together in a linear chain according to their serial order in the Morison text. Here, of course, each fact has two neighbors, except for the initial

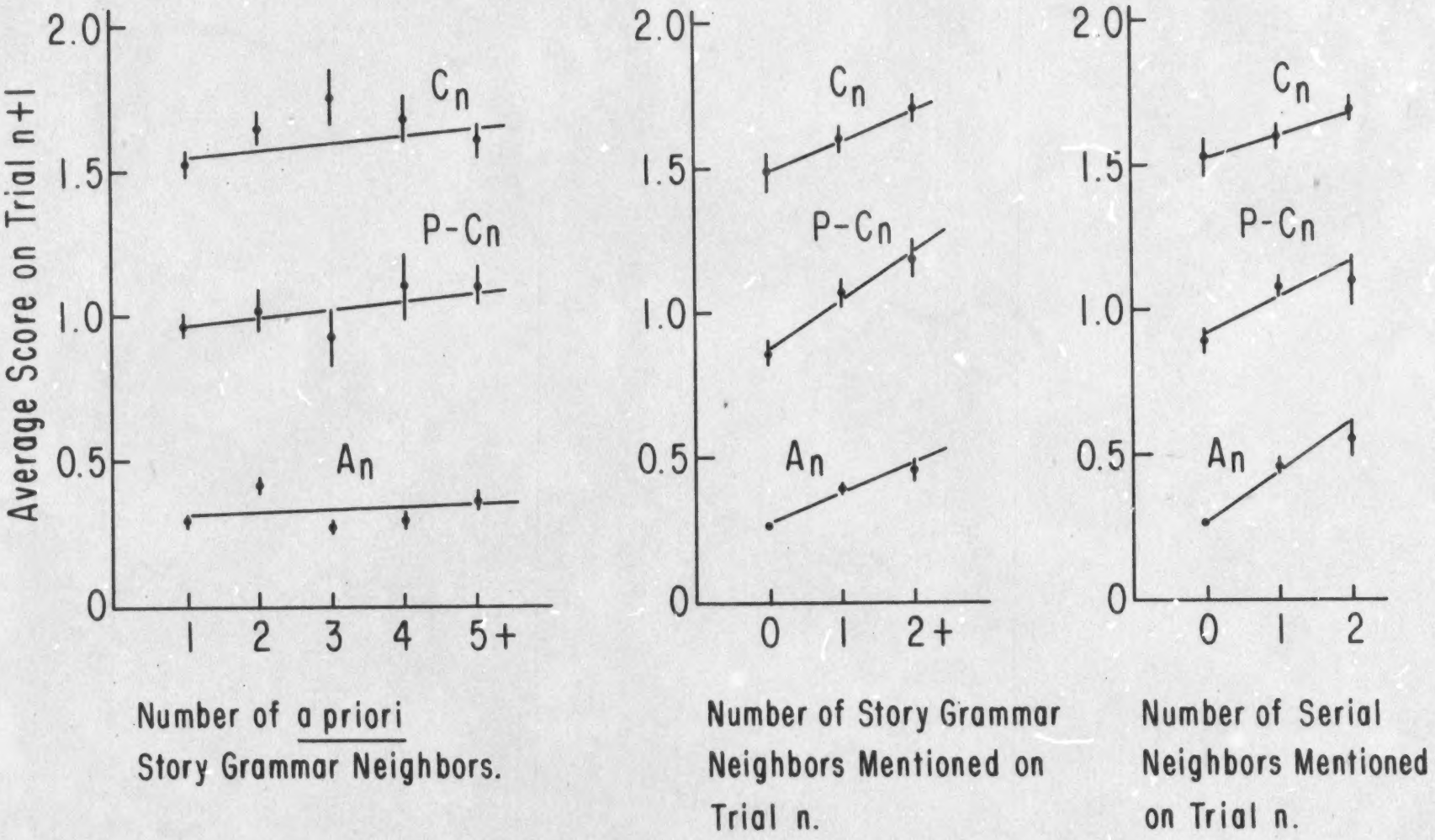

Figure 3. The effect of neighbors (on trial n) in the story grammar and serial structures on the average score for a fact (on the trial n+1). Scoring: Absent = 0, Part-correct = 1, Correct = 2. C_n, $P\text{-}C_n$, and A_n indicate facts which were respectively correct, part-correct, and absent on trial n. The vertical bars indicate $\pm$ 1 standard error.

Table 1

Effect of Neighbors (on Trial n) on Average Score (on Trial n+1)

Linear Regression Analysis

Independent Variable	Status of Fact on Trial n: Absent Slope	Absent t^a	Part-Correct Slope	Part-Correct t	Correct Slope	Correct t
Number of a priori Story Grammar Neighbors	.011	1.53	.032	1.68*	.024	1.34
Number of Story Grammar Neighbors Mentioned on Trial n	.108	6.54***	.173	4.20***	.105	2.69**
Number of Serial Neighbors Mentioned on Trial n	.172	8.86***	.125	2.94**	.080	2.04*
Number of Both Story Grammar and Serial Neighbors Mentioned on Trial n	.230	7.42***	.148	2.42**	.159	3.16***
Number of Story Grammar but not Serial Neighbors Mentioned on Trial n	.061	3.38***	.141	3.30***	.043	1.18
Number of Serial but not Story Grammar Neighbors Mentioned on Trial n	.131	5.36***	.069	1.42	-.018	-.43

[a]The t values test the hypothesis that the slope is not greater than zero.

*$p<.05$

**$p<.01$

***$p<.001$

and final facts. The graph on the right side of Figure 3 shows the effect of the number of serial neighbors mentioned on trial n, on the average score for a fact on trial n+1. There is also a clear effect here, comparable to that for the story grammar structure. Of course there is considerable overlap between the story grammar and serial structures, as we should expect if the syntax of the passage (the serial structure) reflects the semantics of the passage (the story grammar structure). In this particular case, 30% of the facts which are neighbors in the story grammar structure are also neighbors in the serial structure, while 38% of the facts which are neighbors in the serial structure are also neighbors in the story grammar structure. The question still remains, however, as to what extent our effects reflect the story grammar structure, and to what extent they simply reflect the serial order of the facts in the passage.

To separate the effect of the story grammar and serial structures, a multiple linear regression analysis of the data was carried out. The results of this analysis are shown in Table 2. When a fact is absent on trial n, serial neighbors mentioned on trial n are almost three times as effective as story grammar neighbors in improving the recall for that fact on trial n+1. When a fact is part-correct or correct on trial n, however, story grammar neighbors mentioned on trial n are more effective than serial neighbors in improving recall on trial n+1.

The effects of the story grammar and serial structures were also compared in a somewhat different manner by separating the neighbors of each fact into three groups: first, those which were

Table 2

Comparison of Effect of Story Grammar and Serial Neighbors (on Trial n) on Average Score (on Trial n+1)

Multiple Linear Regression Analysis

Independent Variable	Status of Fact on Trial n: Absent Slope	Absent t[a]	Part-Correct Slope	Part-Correct t	Correct Slope	Correct t
Number of Story Grammar Neighbors Mentioned on Trial n	.056	3.10***	.149	3.45***	.094	2.36**
Number of Serial Neighbors Mentioned on Trial n	.143	6.69***	.077	1.75*	.063	1.58

[a]The t values test the hypothesis that the slope is not greater than zero.

*p<.05

**p<.01

***p<.001

neighbors in both the story grammar and serial structures; second, those which were neighbors in the story grammar structure but not in the serial structure (story grammar-only); third, those which were neighbors in the serial structure but not in the story grammar structure (serial-only). The results of this analysis are shown in Table 1. Again we see that the serial-only neighbors have a stronger positive effect on the subsequent recall of absent facts. However, while both serial-only and story grammar-only neighbors have positive effects on the subsequent recall of part-correct facts, the story grammar-only neighbors have the stronger effect. Finally, while the story grammar-only neighbors have a positive effect on the subsequent recall of correct facts, serial-only neighbors have no effect.[3]

DISCUSSION

In this study I have analyzed a natural narrative prose passage into two structures: a serial structure based on serial order in the passage, and a story grammar structure based primarily on causal relations within the passage. The results show that these structures are important for the memory and recall of the passage.

If we look at some particular fact on a given trial, the number of neighbors of that fact (according to either the serial or story grammar structure) which the subject has also mentioned will influence the recall of that fact on the next trial. In general, as a fact has more neighbors mentioned, it is more likely that the fact will be remembered correctly, and less likely that it will be forgotten, on the next trial. However, there are important differences in the

effects of the serial and story grammar structures. When a fact is absent on trial n, the number of neighbors in both the serial and story grammar structures mentioned on trial n affects the recall of that fact on trial n+1, but the number of neighbors in the serial structure has the greater effect. When a fact is partially-correct on trial n, again neighbors in both structures mentioned on trial n affect the recall of that fact on trial n+1, but now the number of story grammar neighbors mentioned has the greater effect. Finally, if a fact is correct on recall n, its recall on trial n+1 is influenced only by the number of its neighbors in the story grammar structure also mentioned on trial n; the number of its neighbors in the serial structure mentioned on trial n does not have any effect.

This pattern of results has a simple explanation. On first hearing the tape recording, the subjects perceive the passage as a collection of sentences or facts strung together in serial order, but as portions of the passage begin to "make sense," they perceive and organize the passage in a manner closer to its underlying meaning structure: the serial order loses its importance. I found that only the neighbors in the story grammar structure actually mentioned by the subject on one recall will affect performance on the subsequent recall. The structure inherent in a prose passage has no effect unless it is present in the subject's memory for that passage.

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Footnotes

[1]The straight lines shown in Figure 3 are the least-squares fit to the data, with the points weighted in proportion to the number of cases they represent. For example in Figure 3 there were 1891 cases of an absent fact with one neighbor in the story grammar structure, but only 623 cases of an absent fact with two neighbors. Therefore these data were weighted in the ratio of 1891 to 623 in determining the least-squares-fit line.

While the maximum number of neighbors in the serial structure is two, facts can have up to seventeen neighbors in the story grammar structure. In order to simplify the graphs and make a fairer comparison between story grammar and serial neighbors, in the center graph of Figure 3 data for more than two story grammar neighbors mentioned (5% of the total data) have been grouped with data for two neighbors mentioned. Similarly, in the left graph in Figure 3, data for more than five *a priori* story grammar neighbors have been grouped with data for five neighbors. This procedure does not materially affect the results or conclusions in either case.

[2]Of course, the number of *a priori* neighbors is not completely independent of the number of neighbors actually mentioned by a subject, since for instance a fact with five neighbors in the complete structure has a greater potential number of mentioned neighbors than a fact with only one neighbor in the complete structure.

[3]This paper reports the effect of the number of mentioned neighbors (on trial *n*) on the average score for a fact (on trial *n+1*). I have also analyzed the data using other methods of scoring facts, looking at the effect of the number of correct neighbors, and assigning different weights to correct and part-correct neighbors. These analyses all yield results essentially identical to those presented here.